# Statistical analysis of the sampling design: FishPi case study on the biological sampling of the European hake fishery

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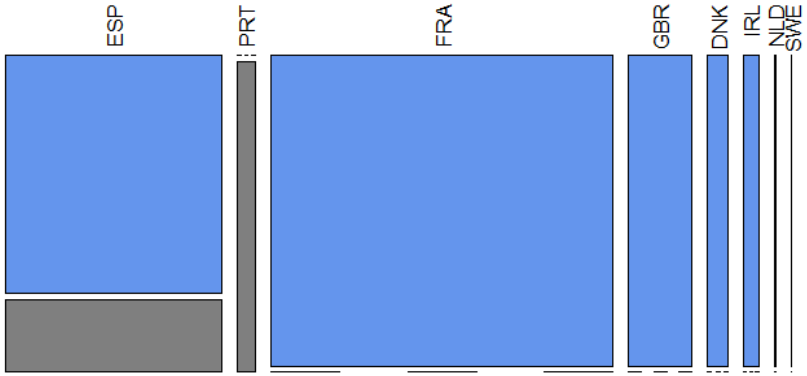
WP2 / The fishPi project
Regional co-operation in fisheries data collection

This work package was tasked with running **simulation models of the sampling** to test regional sampling designs for the fisheries exploiting regional stocks.

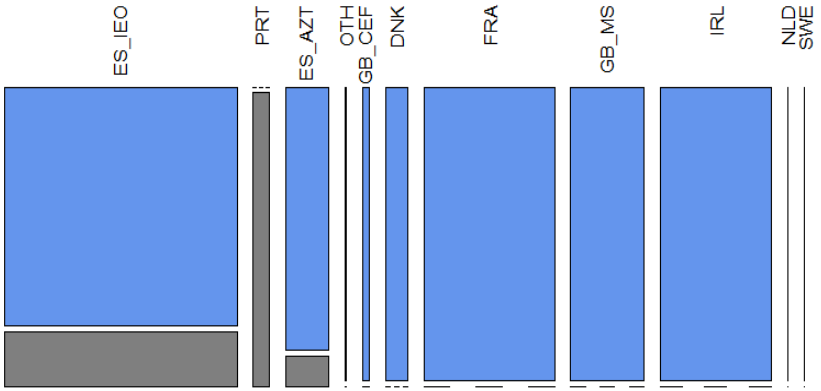
This simulation studies were prepared to **mimic the random selection of fishing trips** from the regional population of trips for that fishery.

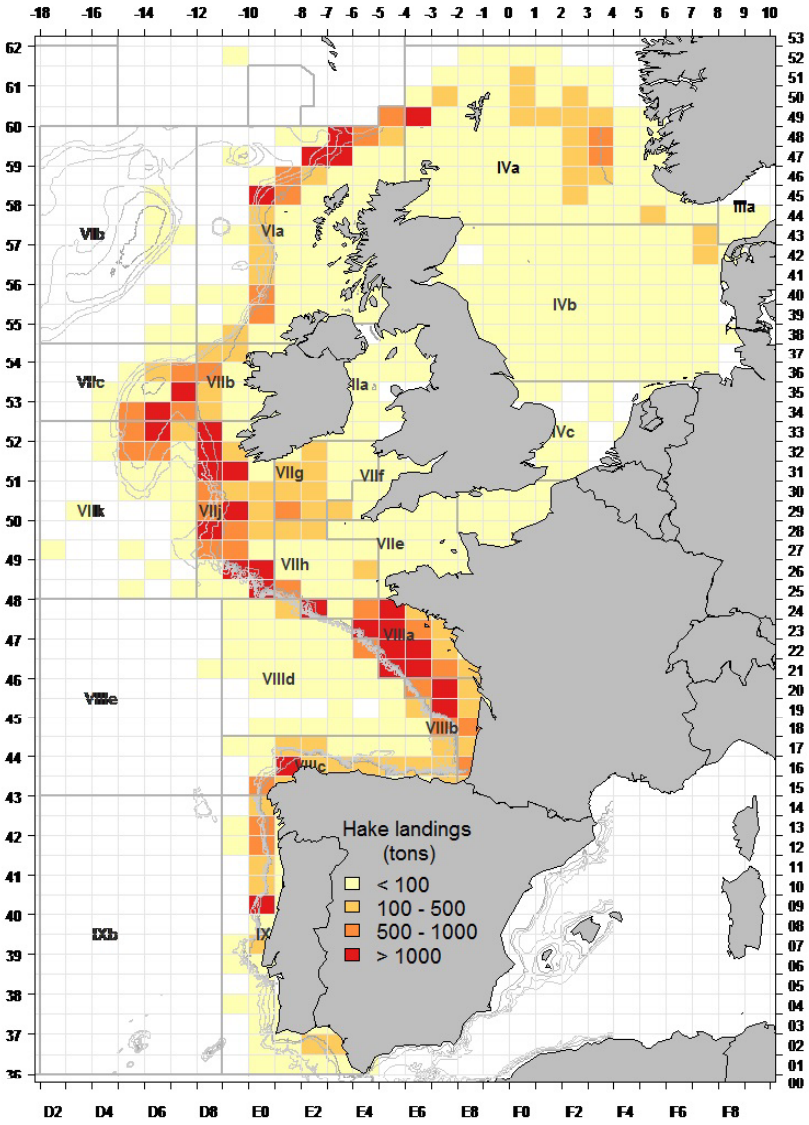
The study focus on the statistical optimization of **landings estimates**.

## Landings (mean 2013-2014) by vessel flag




## Landings (mean 2013-2014) by sampling Institute




Field "**onShoreSampLoc**" indicates the **country responsible for the sampling** and is fundamental to organize a regional sampling program.

## CS4-total: list of scenarios

2-stage random sampling
PSU: market/port and day
SSU: trip

1. Baseline scenario: SRS
2. Scenario COUNTRY
3. Scenario INSTITUTE
4. Scenario REGIONAL stratified by PORT
5. Scenario COUNTRY and PORT
6. Scenario INSTITUTE and PORT

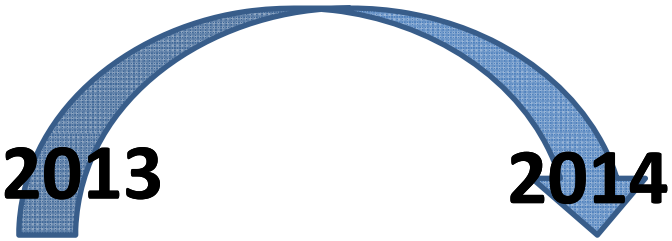
## CS4-southern: list of scenarios

2-stage random sampling
PSU: market/port and day
SSU: trip

1. Base line scenario: SRS

2. Scenarios REGIONAL.
   - 2a REGIONAL stratified by port
   - 2b REGIONAL stratified by quarter
   - 2c REGIONAL stratified by port-quarter

3. Scenarios COUNTRY
   - 3a COUNTRY stratified by port
   - 3b COUNTRY stratified by quarter
   - 3c COUNTRY stratified by port-quarter




to set stratification
and sample allocation

to run simulations
of each scenario

## Main criteria used in selecting the ”best” scenarios

- Relative Bias:

  Ratio between the estimatesd values (tons of hake) and the true value registered in 2014

- Relative Precison:

  Ratio between the standard error (SE) of the estimated values of each scenario and the SE of Scenario 1 (*i.e.* 2-stage SRS not stratified)

- Coverage by country:

  n PSUs, n SSUs, n SSUs with hake, tons hake available for sampling

- Coverage by domain:

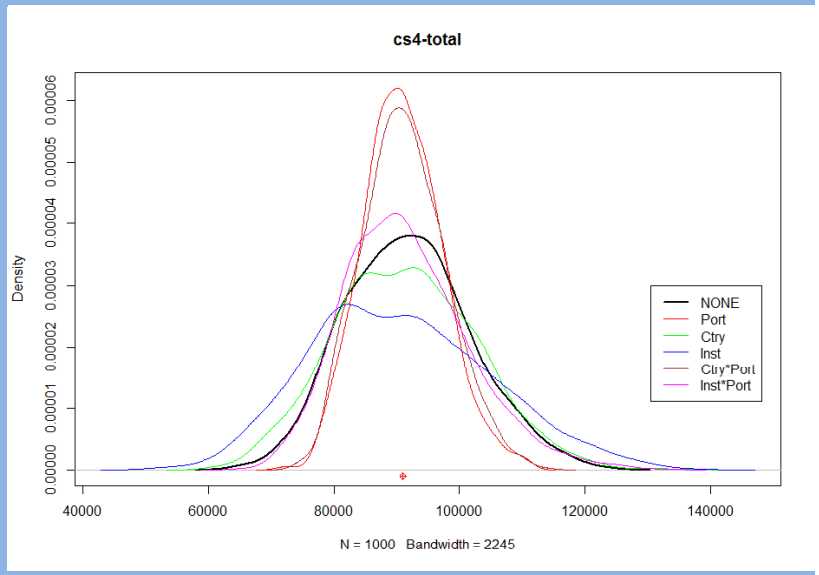
  n PSUs, n SSUs, n SSUs with hake, tons hake available for sampling

  - Country
  - Port and Quarter
  - Stock
  - FleetNat
  - FoCatEu6

## CS4 - TOTAL SIMULATIONS RESULTS

Highest precision
- scenario 4: **REGIONAL** STRATIFIED BY **PORT**
- scenario 5: **COUNTRY** AND **PORT**

| Scenario | Sampling design | Precision |
|---|---|---|
| 1 | 2-stage SRS (not stratified) | baseline |
| 2 | Stratified by Country | 1.14 |
| 3 | Stratified by Institute | 1.44 |
| 4 | REGIONAL stratified by PORT | **0.63** |
| 5 | Stratified by COUNTRY and PORT | **0.67** |
| 6 | Stratified by INSTITUTE and PORT | 1.00 |




| Institute | Current data | Port | Country/Port |
|---|---|---|---|
| | Nsamp_marketdays | SampTrips | SampTrips |
| ES_IEO | 765 | 1035 | 652 |
| PT | 700 | 109 | 700 |
| FR | 597 | 882 | 597 |
| GB_CEFAS | 431 | 38 | 132 |
| DK | 113 | 104 | 113 |
| IE | 82 | 226 | 82 |
| ES_AZTI | 43 | 230 | 156 |
| NL | 38 | 3 | 38 |
| GB_MS | 11 | 189 | 344 |
| SE | 3 | 1 | 3 |

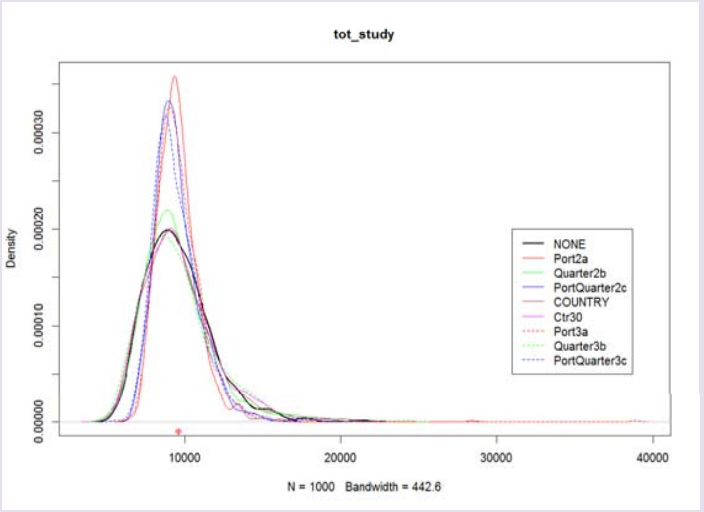
## CS4 - SOUTHERN SIMULATION RESULTS

Highest precision:

- scenario 2a: REGIONAL stratified by PORT
- scenario 2c: REGIONAL stratified by PORT-QUARTER

→ *The most precise overall but provide less coverage to some metiers and national fisheries.*

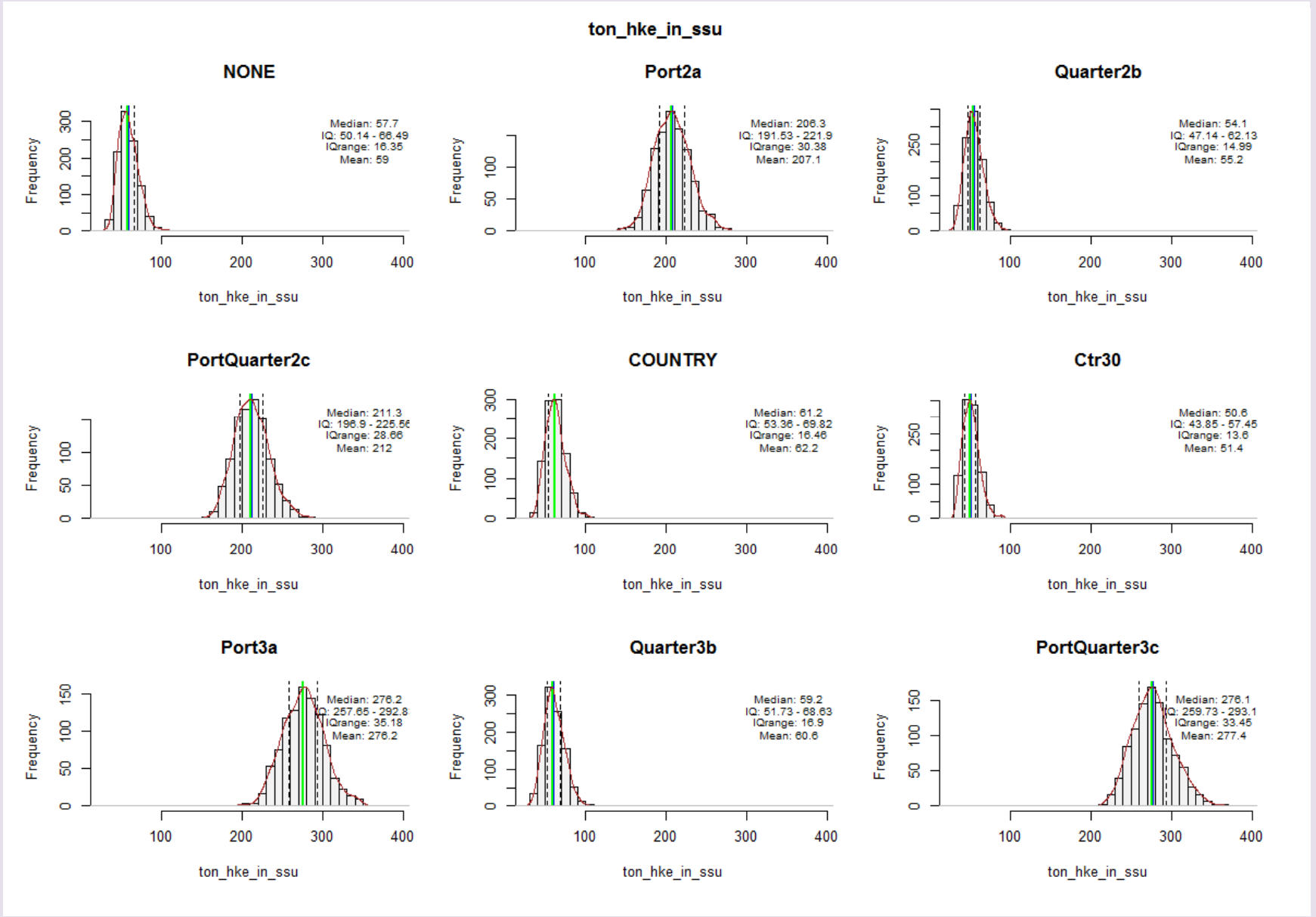
| Scenario | sampling design | Precision |
|---|---|---|
| 1 | 2-stage SRS WR (no stratified) | Baseline |
| 2a | Regional stratified by port | **0.67** |
| 2b | Regional stratified by quarter | 1.05 |
| 2c | Regional stratified by port*quarter | **0.68** |
| 3 | Stratified by country | 1.11 |
| 3a | Stratified by country and port | 0.80 |
| 3b | Stratified by country and quarter | 1.17 |
| 3c | Stratified by country and port*quarter | 0.76 |
| 3o | Stratified by country (proportional to landings) | 1.09 |



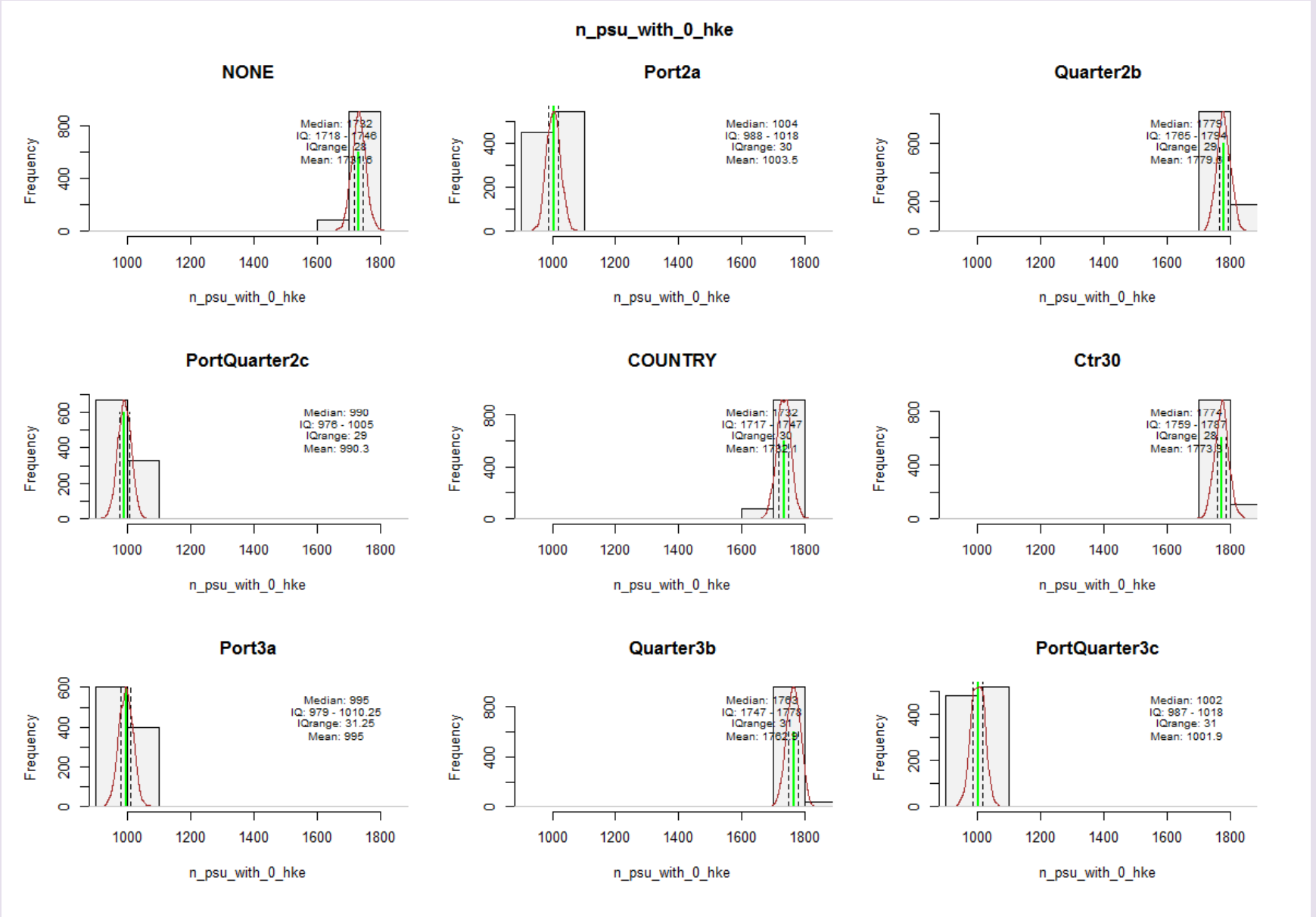

The second best-performing results were provided by scenarios 3a and 3c where the COUNTRY stratification is extended to PORT and PORT-QUARTER stratifications.

→ *Less precision in the estimation of total hake landings* ***but improved "tonnes of hake sampled"*** *and* ***"trips with hake sampled"*** *while providing* ***better coverage in some areas*** *with smaller hake landings.*

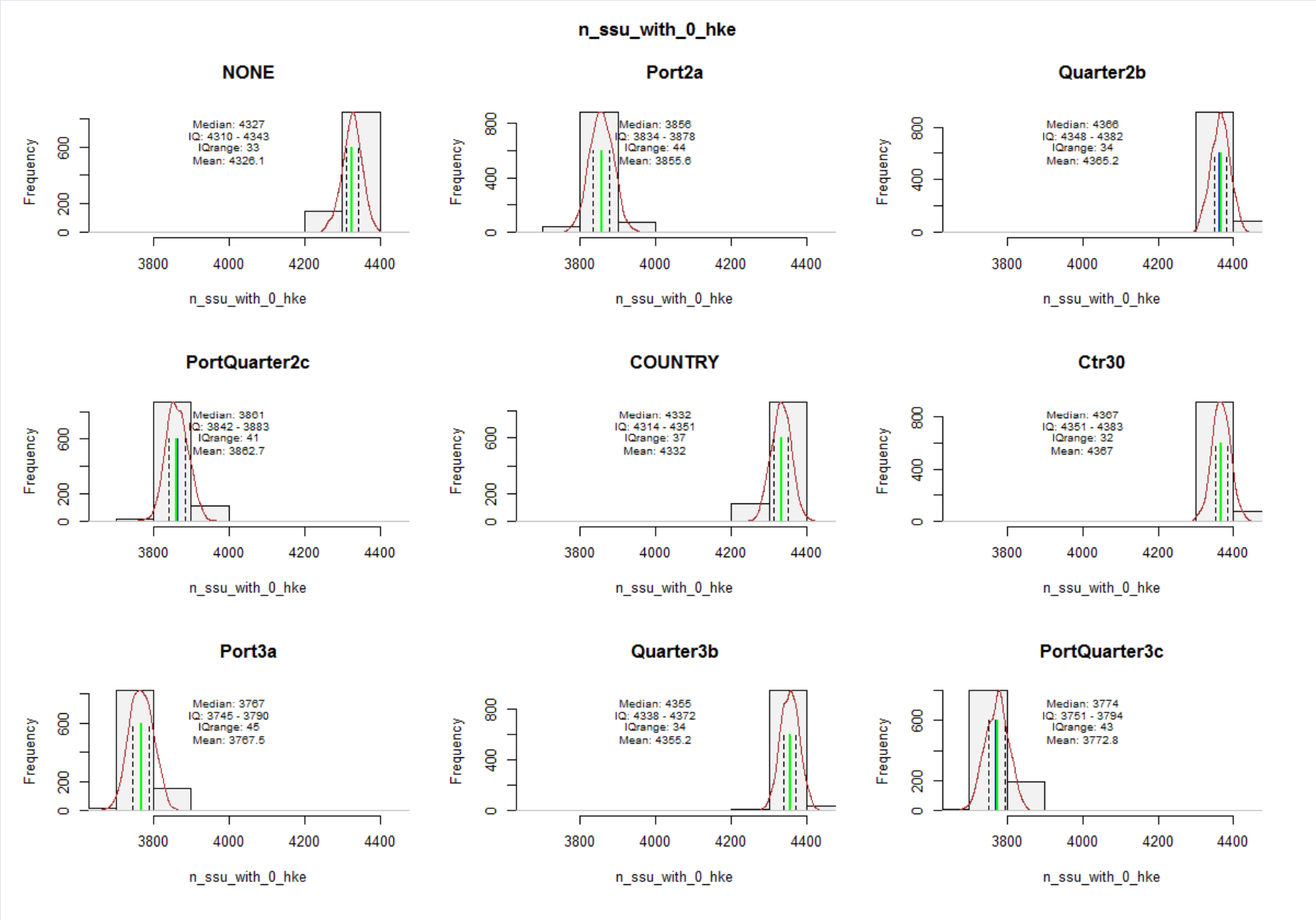
# CS4 - SOUTHERN SIMULATION RESULTS (examples: tonnes of Hke “sampled”)



# CS4 - SOUTHERN SIMULATION RESULTS (examples: market_days without hake)



# CS4 - SOUTHERN SIMULATION RESULTS (examples: trips without hake)



## CS4-southern hake: Methodological insights
## Comparison between scenarios with all days and positive trips

### Insights from CS4:

- Do we really know exactly in which market*days and trips our target stocks will occur?
- Does this affect our perceptions on the quality of designs and how much Regional Sampling Plans can deliver?

| **All market days All trips** | **All market days Positive trips** | **Positive market days Positive trips** |
|---|---|---|
| ↓ | ↓ | ↓ |
| All possible markets (and days) Random selection of market*days Random selection of **all trips** present in each markey*day | All possible markets (and days) Random selection market*days Random selection of **trips with HKE** in each | Only market (and days) that ***will*** register HKE Random selection of **trips with HKE** in each market*day |
| Design targets all fisheries (basic scenario for CS4 SthHKE) | Design targets hake fisheries (other species would be ”sampling by-catch”) | Design targets hake fisheries *realistic? can we assume to know the exact days of arrivals?* |

## CS4-southern hake: Methodological insights
## Comparison between scenarios with all days and positive trips

### Implications on size of the simulation dataset (2014)

| | all market*days all_trips | all market*days pos_trips | pos market*days pos_trips |
|---|---|---|---|
| No. Markets | 186 | 186 | 151 |
| Market*days with hake landings | 34849 | 34849 | 19074 |
| No. Market*days | 67890 | 67890 | 19074 |
| No. Trips | 584012 | 152465 | 103649 |

We ran simulations of these 3 setups using the same sampling effort and design Port2a (Regional Port Strata)

# CS4-southern hake: Methodological insights
## Comparison between scenarios with all days and positive trips

| | Expected value (mean) from 1000 sims | | | InterQuartile Range | | |
|---|---|---|---|---|---|---|
| type | all_marketdays all_trips | all_marketdays pos_trips | pos_marketdays pos_trips | all_marketdays all_trips | all_marketdays pos_trips | pos_marketdays pos_trips |
| tot_study | 9592 | 9638 | 9606 | 1553 → | 1068 → | 641 |
| ton_hke_in_ssu | 207 → | 503 → | 769 | 30 | 46 | 53 |
| | | | | | | |
| n_ssu_with_hke_27.8.c | 490 → | 1283 → | 2137 | 30 | 40 | 33 |
| n_ssu_with_hke_27.9.a | 472 → | 1531 → | 2687 | 29 | 44 | 33 |
| tons_hke_sampled_27.8.c | 160 → | 353 → | 542 | 29 | 43 | 49 |
| tons_hke_sampled_27.9.a | 47 → | 150 → | 227 | 8 | 15 | 17 |
| | | | | | | |
| n_ssu_with_hke_OTB_DEF_>=55_0_0 | 154 → | 473 → | 724 | 18 | 32 | 37 |
| tons_hke_sampled_OTB_DEF_>=55_0_0 | 29 → | 90 → | 131 | 9 | 15 | 20 |

→ Sharp increase in expectations

# Considerations for selections of regional design

**Datasets to use:** define strata and sampling intensity and simulate on different datasets; consider throughly if datasets with only positive trips are applicable

**Precision**: analyze the scenarios with acceptable precision.

**Coverage by country**: analyze the **deviations that occur with respect to the current coverage.**

**Coverage by domain**: analyze the **deviations that occur in estimates of domains currently used by the National institutes to provide commercial data to ICES**: technical (métier), spatial (ICES Division), and time (quarter) disaggregation.

**Indicators of efficiency:** consider indicators like mean and variance of *n_ssu_with_spp* and *ton_spp_in_sampled_ssu* per species, strata and post_strata) should be a part of outputs so we approximate better what we can expect from design.

**Match real-life fleet operation conditions**: E.g., all days of the year should be included unless specific days are known not to have any landings; all fleets should be included unless specific fleets are known to have negligible landings with similar fish size/age structures.

**Adequacy to multiple end-user needs**: A regional sampling design should aim at **estimating accurate length/age composition** of the landings of the hake stocks for stock assessment purposes while at the same time providing **accurate estimates for many other stocks and fisheries subject to assessment**. The current study focused on estimating total landings of hake which are hardly a proxy for size/age.